U.S. GEOLOGICAL SURVEY NATIONAL COMPUTER TECHNOLOGY MEETING: PROGRAM AND ABSTRACTS, MAY 7-11, 1990

Compiled by Barbara H. Balthrop and Eva G. Baker

U.S. GEOLOGICAL SURVEY

Open-File Report 90-161

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Nashville, Tennessee
1990

Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE **1990**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
U.S. Geological Survey National Computer Technology Meeting: Program and Abstracts, May 7-11, 1990	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Department of the Interior 1849 C Street, NW Washington, DC 20240**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**SAR**	**73**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

FOREWORD

The Water Resources Division of the U.S. Geological Survey has made major advancements in the use of computer technology to meet the Survey's mission of providing the hydrologic information and understanding needed for the optimum use and management of the Nation's water resources. The Division requires substantial computer technology to process, store, and analyze data from about 60,000 sites. To meet this workload, the Division organized its computer resources in 1982 through the Distributed Information System (DIS) Program Office, which manages the Division's national network of computers. The DIS is designed to provide computer resources in support of the Division's current and future activities — acquisition and storage of hydrologic information, hydrologic data analysis, geographic information systems, reports and electronic report processing, and administration.

The Water Resources Division sponsored the first DIS Site Administrators' Meeting in March 1984 in Denver, Colorado, and a second meeting in October 1985 in Hyannis, Massachusetts. The thrust of the first two national meetings was the training of Water Resources Division personnel in the use and administration of the Division's computer hardware and software. Starting with the third meeting, which was held in Atlanta, Georgia, in May 1987, the name was changed to the National Computer Technology Meeting because the format evolved to include presentation of papers prepared by computer and scientific personnel in the Division. These papers document work done in the field of computer science as applied to hydrology, including the design and use of geographic information systems, use of nationally distributed software, the development of procedures for data-base management, and research papers on the expanding field of computer technology.

Training continues to be a major part of the National Computer Technology Meeting. This year's meeting includes training on the use of UNIX operating system, UNIX system administration and security, the C programming language, local area networking, as well as a publication seminar. This report includes abstracts for papers and posters that have been accepted for presentation at the Fifth National Computer Technology Meeting.

Colleen A. Babcock
Technical Cordinator

iii

CONTENTS

PROGRAM

Monday Morning, May 7, 1990

SYSTEM ADMINISTRATOR'S INFORMATION SESSION
Moderator, Gail E. **Kalen**, WRD, Reston, VA

Tuesday Morning, May 8, 1990

PLENARY SESSION
Moderator, Gary **Cobb**
Chief, Branch of Computer Technology,
WRD, Reston, VA

Page

8:00- 8:40 a.m. GREETINGS

SAN ANTONIO SUBDISTRICT, Rodger F. **Ferreira**
TEXAS DISTRICT, Larry F. **Land**
CENTRAL REGION, James F. **Blakey**
HEADQUARTERS, James F. **Daniel**

PERSPECTIVES — John N. (Jack) **Fischer**, Associate Chief Hydrologist,
Water Resources Division

8:40- 8:50 a.m. INTRODUCTION OF KEYNOTE SPEAKER

8:50- 9:30 a.m. KEYNOTE SPEECH — Michael F. **Morris**, Program Manager,
IDC Washington Systems and International Planning Service

9:30- 9:40 a.m. Remarks on Concurrent Sessions
C.D. **Nethaway**, Jr., Reston, VA

10:00-12:00 a.m. Be Your Own Computer Programmer
Joel L. **Agran**, OPM Executive Training Instructor

Tuesday Afternoon, May 8, 1990

HYDROLOGIC APPLICATIONS SESSION
Moderator, Charles (Bill) **Boning**
Chief, Office of Surface Water, WRD, Reston, VA

CONCURRENT TRAINING SESSIONS

Wednesday Morning, May 9, 1990

PLENARY SESSION
Moderator, James E. **Biesecker**, Assistant Director for
Information Systems, USGS, Reston, VA

Wednesday Afternoon, May 9, 1990

NATIONAL WATER INFORMATION SYSTEMS SESSION
Moderator, Thomas H. Yorke, Chief, National Water Information
System Program Office, WRD, Reston, VA

CONCURRENT TRAINING SESSIONS

Thursday Morning, May 10, 1990

**GEOGRAPHIC INFORMATION SYSTEM APPLICATIONS
AND TECHNIQUES SESSION**
Moderator, Verne R. **Schneider**, Assistant Chief Hydrologist for Program
Coordination and Technical Support, WRD, Reston, VA

Thursday Afternoon, May 10, 1990

**DISTRIBUTED INFORMATION SYSTEM-II PROGRAMMING
TECHNIQUES SESSION**
Moderator, James L. (Jim) **Cook**, Regional Hydrologist,
Southeastern Region, WRD, Atlanta, GA

CONCURRENT TRAINING SESSIONS

8:00-12:00 p.m. Publication Seminar
Celso **Puente**, WRD, Reston, VA, and B.H. Balthrop,
WRD, Nashville, TN

1:00- 3:00 p.m. Local Area Networking
D.L. **Chinn**, WRD, Reston, VA

Friday, May 11, 1990

PLENARY SESSION
Moderator, James F. **Daniel**, Assistant Chief Hydrologist
for Scientific Information Management,
WRD, Reston, VA

8:00- 8:20 a.m. The Use of Worm-Drive Optical Medium on a 32-Bit Workstation
as a Means of Storage of Image and Digital Data
B.L. **Groskinsky**, EPA (formerly with the WRD,
Portland, OR), Environmental Services Division,
Region 7, Kansas City, KS

8:20- 8:40 a.m. A District Program Reporting System (DiPRS) for the U.S.
Geological Survey, Water Resources Division
L.F. **Land**, WRD, Austin, TX

9:40-10:40 a.m. PANEL DISCUSSION — Moving Software Applications and Users
to the Distributed Information System-II Platforms
Moderator, Arlen **Harbaugh**, WRD, Reston, VA

10:40-11:30 a.m. Wrap-up of Meeting

David E. **Click**, District Chief, Harrisburg, PA — District Perspective
Keri J. **Hitt**, Staff Professional, Reston, VA — Headquarters Perspective
Jonathan C. **Scott**, Staff Professional, Oklahoma City, OK — District
Perspective
Charles D. **Nethaway**, Jr., Reston, VA — Technology Perspective

VIDEO TRAINING SESSIONS

The following video training sessions will be presented multiple times during NCTM 90:

FUNDAMENTALS OF THE UNIX SYSTEM - BASIC LEVEL ($2^1/_2$ hours)

The Structure of the UNIX System
Basic User Communications
The File Structure
The vi Screen Editor - Part 1

FUNDAMENTALS OF THE UNIX SYSTEM - INTERMEDIATE LEVEL ($2^1/_2$ hours)

The Interactive Shell and Shell Commands
Advanced User Communications
File Access and Manipulation
The vi Screen Editor - Part 2

FUNDAMENTALS OF THE UNIX SYSTEM - ADVANCED LEVEL ($1^1/_2$ hours)

Shell Procedures and Background Processing
Searching, Sorting, and Comparing Files
Introduction to Text Processing

UNIX SYSTEM ADMINISTRATION (2 hours)

Daily Tasks of a UNIX System Administrator
Administrative Files
Managing File Systems
Utility Package Administration

C LANGUAGE FOR PROGRAMMERS - PART 1 (2 hours)

Getting Started - Part 1
Getting Started - Part 2
Arrays and Flow Control

C LANGUAGE FOR PROGRAMMERS - PART 2 (2 hours)

Formatted Input/Output
Operators and Precedence
Functions and Storage Classes

C LANGUAGE FOR PROGRAMMERS - PART 3 (2 hours)

The C Processor and Program Organization

Pointers
Structures and Unions

C LANGUAGE FOR PROGRAMMERS - PART 4 ($1^1/_2$ hours)

File Input/Output
Advanced Pointer Use and Special Topics
Style and Debugging

CONVERSION FACTORS

For readers who may prefer to use metric units rather than the inch-pound units used herein, the conversion factors are listed below:

Multiply inch-pound unit	By	To obtain metric unit
inch (in.)	2.540	centimeter (cm)
	25.40	millimeter (mm)
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer (km^2)
acre	0.4047	square hectometer (hm^2)

The use of brand, company, or trade names in the report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

OPTICAL SCANNING OF GEOLOGIC MAPS FOR INPUT TO A GEOGRAPHIC INFORMATION SYSTEM

ATWOOD, John W., USGS, WRD, 821 E. Interstate, Bismarck, ND 58501

A Tektronix 4991 optical line scanner was used to digitize several 1:250,000-scale maps that depict the surface geology of Oklahoma. The optical line scanner reduced the time and the cost of producing polygon coverages of geologic contacts for the geographic information system ARC/INFO. The project demonstrated that optical line scanning of maps may be an alternative to digitizing maps manually. The purpose of this poster is to illustrate one method of producing an acceptable polygon coverage using an optical line scanner as the primary digitizing device. Line and polygon features of any map may be digitized using this method.

The optical line scanner senses only contrasting light and dark areas of maps and does not discriminate colors. Scanned images are converted to and stored in a data file as a series of vectors or lines. Therefore, line separates of the desired map features must be used to produce an acceptable vector file. Both positive and negative line separates were used successfully for the project. All line separates were on a scale-stable mylar base.

The optical line scanner produces a flat file containing the coordinates of points that define each vector. A vector file was produced for each map scanned. A Fortran program was written to convert the vector files to a format acceptable to ARC/INFO's GENERATE routine, and each of the vector files was converted using the Fortran program. The converted vector files were stored in ARC/INFO line coverages using the GENERATE command. The line coverages then were transposed into new line coverages with real-world coordinates. Unwanted vectors were deleted, and the line coverages were converted to polygon coverages. Geologic formation names were added as attributes to each polygon coverage to complete the project.

The final coverages were adequate for the project, and the time required to digitize the maps by optical line scanning was less than the time required to digitize the maps manually.

PROXIMITY ANALYSIS: A TOOL FOR COMPARING DATA BASES

AUGENSTEIN, Todd W., USGS, WRD, 3600 W. Broad St., Rm. 606,
Richmond, VA 23060; TERZIOTTI, Silvia, Virginia Council on the
Environment, 202 N. 9th St., Suite 900, Richmond, VA 23219; HOM,
Penny J., USGS, WRD, 3600 W. Broad St., Rm. 606, Richmond, VA 23060

In 1989, a review committee was established to evaluate data stored in
the U.S. Geological Survey's Ground Water Site Inventory (GWSI). Part
of the evaluation included the development and application of
methodology and supporting software to compare data for sites in GWSI
to data for other sites in GWSI and to data contained in the Survey's
New Site Specific Water-Use Data System (NEWSWUDS). The purpose of
this comparison was to estimate the number of duplicate sites entered
into GWSI, the number of sites common to both data bases, and the
number of sites present in one data base but missing from the other.
Sites were first compared on the basis of geographic location
(proximity analysis). Then sites were compared on the basis of
similiar data elements (data-element comparison) and information
obtained from proximity analysis.

This paper describes the proximity-analysis component of the
comparison and its use by personnel from the Virginia Cooperative
Water-Use Program [a cooperative program between the Commonwealth of
Virginia and the U.S. Geological Survey]. Proximity analysis is
conducted by retrieving latitude, longitude, and other selected data
elements from GWSI and NEWSWUDS, entering these data into a
geographic-information system (GIS), and then applying the computer
software to identify site locations within a user-specified distance.
A distance file is created during the proximity analysis. The
distance file is used along with the selected data elements entered
into the GIS to generate a report of selected data for potential sites
duplicated within or between data bases. In addition, the distance
file and the selected data elements are combined in a single file.
This file is used by software that performs data-element comparison
and generates reports for the evaluation of GWSI.

As part of the Virginia Cooperative Water-Use Program, proximity
analysis was used to compare data from GWSI and NEWSWUDS. The
comparisons in the generated report were then manually reviewed. The
proximity analysis aided in identifying different data sets for the
same site.

A COMPUTER PROGRAM FOR DETERMINING STREAMFLOW AVAILABILITY
BAXTER, Carmen R., USGS, WRD, 2301 Federal Office Bldg., Little Rock, AR 72201; TERRY, J.E., USGS, WRD, 2301 Federal Office Bldg., Little Rock, AR 72201

A hydrologic investigation of the Little Red River in Arkansas was conducted in 1983 and 1984 to obtain information that can be used by State regulatory agencies in making streamflow allocation decisions. This investigation led to the development of a mass balance procedure used to estimate the amount of streamflow available for diversion at any point along a given reach with a minimum instream flow requirement. This procedure was coded into an interactive computer program.

The streamflow availability computer program requires control data at the upstream and downstream ends of a stream reach to be analyzed and flow data for intervening tributaries and existing diversions. The computation interval is selected by the user on the basis of number of subdivisions per mile. Tables output from the program include total flow, quantity of water available for diversion, and minimum flow required at each computation interval. An additional option is output of a hydrograph comparing amounts of total flow, minimum flow, and available flow at reach locations.

AUTOMATED DATA COLLECTION FOR DETECTION OF FLOOD HAZARDS IN CLARK COUNTY, NEVADA

BLACKSTUN, David E., USGS, WRD, 1500 E. Tropicana, Suite 201, Las Vegas, NV 89119; COX, Elaine A., USGS, WRD, 705 N. Plaza, Room 227, Carson City, NV 89701

The Las Vegas Valley in Clark County, Nevada, is vulnerable to high property damage and loss of lives from flash floods. The U.S. Geological Survey and Clark County Regional Flood Control District have begun an Automated Local Evaluation in Real Time (ALERT) network to collect streamflow and weather data to aid early detection of impending floods. The network consists of three main parts: (1) remote stations to collect and transmit data; (2) transmission repeater stations to relay the data and extend the range of the network; and (3) a base station to receive and process the data on a real-time basis.

Seventeen streamflow gaging stations, 11 precipitation stations, and 6 weather stations are operational. Each station is equipped with a precipitation gage, transmitter, solar panel, storage battery, and antenna. Streamflow gaging stations also have a water-stage sensor and data logger, and weather stations have wind-run, wind-direction, relative-humidity, and temperature sensors. Water stage is measured and transmitted in increments of 0.05 foot, precipitation in increments of 0.04 inch, wind run in increments of 4 kilometers and wind direction at the time of transmission, relative humidity in increments of 1.2 percent, and temperature in increments of 3 degrees Fahrenheit.

Three transmission repeater stations have been installed at elevated locations throughout Clark County to relay data from remote sites to the base station. Each repeater station is equipped with a radio transceiver, solar panel, storage battery, and antenna.

The base station has a receiving antenna, a receiver, a decoder, and a desktop computer for receiving, storing, and processing data. The operating software is a multitasking operating system that allows for continuous data reception, storage, and simultaneous data plotting, reporting, and table generation.

SYSTEM MONITORING AT THE HYDROLOGIC INSTRUMENTATION FACILITY

BOYES, David L., Sverdrup Technologies Inc., Bldg. 2101, Stennis Space Center, MS 39529; FORD, Edward L., USGS, WRD, Bldg. 2101, Stennis Space Center, MS 39529

A procedure for monitoring the operation of a computer system is required by the system administrator to ensure the reliability of the system and to make the most efficient use of the computer. A monitoring system captures data that provide a historical basis for capacity planning of computer resources. System-monitoring data are needed for evaluation and testing of new equipment and programs. These data provide timely information for status reports to management.

The major part of the system monitoring procedure at the Hydrologic Instrumentation Facility is accomplished through three steps: the Prime USAGE utility, used as a base; a reduction program that generates statistical data; and daily graphs of the minimum, maximum, and average for selected variables. The plots and printed output generated as part of the system monitoring provide a means of observing the computer's performance. Other utilities are used to investigate specific operations. System monitoring is an extremely valuable and necessary tool used by the system administrator to ensure uninterrupted, high-quality performance of computer resources.

THE APPROACHING RETIREMENT OF THE PRESENT NATIONAL WATER INFORMATION SYSTEM OF THE U.S. GEOLOGICAL SURVEY

BRIGGS, John C., USGS, WRD, MS437, Reston, VA 22092

The National Water Information System (NWIS-I) of the U.S. Geological Survey, which is implemented on minicomputers, is nearing the end of its life cycle. Its replacement, NWIS-II, which is designed for a computer network using workstations operating under Unix, is under development. NWIS-I is composed of four subsystems, the Ground-Water Site Inventory (GWSI), the Water-Use Data System (WUSE), the Quality of Water System (QW), and the Automated Data Processing System (ADAPS). The early versions of NWIS-I software did not meet all of the users' needs or expectations. However, as NWIS-I matured, scheduled releases of revised software and system improvements enabled the system to meet more of the user needs for processing hydrologic data.

The procedures used in the operations and maintenance phase of the NWIS-I software life cycle have been modified in preparation for the retirement of the software. A data-base administrator for each subsystem handles user problems, and is responsible for the implementation, release, and maintenance of the subsystem's software and documentation. Development of new programs or major enhancements to existing programs has stopped. Maintenance continues but is limited primarily to correcting reported software errors and preparing the system to transfer data to NWIS-II. A limited number of enhancements to NWIS-I that are deemed critical by technical or program offices are being made, but resources to make these enhancements are supplied by the requesting office. Releases of revised software are scheduled twice yearly, usually in January and July. Additional software systems, such as the Survey's DECODES system, which are not part of NWIS-I but are dependent on compatibility with NWIS-I software, are distributed with each software release. NWIS-I data-base administrators will be increasingly involved in the development of NWIS-II, particularly in the conversion of NWIS-I data format to NWIS-II format.

INTEGRATING TEXT AND GRAPHICS BY USING A WORD-PROCESSING SOFTWARE
PACKAGE

    BUNCH, Robin L., USGS, WRD, 705 N. Plaza St., Room 227,
    Carson City, NV 89701

Text and graphics can be combined on a single page by using a word-
processing software package available for Prime computers and that is
capable of proportional spacing, graphics importation, and Postscript
output. This is accomplished without the addition of separate
desktop report processing software and specialized hardware, such as
a full-page monitor or a mouse.

    The draft text is changed from double-spaced to single-spaced
and from nonproportionally spaced to proportionally spaced. Multiple
sizes and styles of type (fonts) are selected and stored with each
report file.

    Next, graphics that have been produced by a separate software
package in Encapsulated PostScript format are incorporated with the
text. The graphics can be positioned almost anywhere on a page. The
proportionally spaced text may precede, flow next to, and follow the
incorporated graphics. An output file of the entire document is then
created and printed.

    The final product is professional in appearance, with the inclusion
of computer-generated graphics and multiple sizes and styles of type.
On the average, the printed report has about 25 percent fewer pages
than if produced with nonproportionally spaced type.

DIGITAL SYSTEMS DEVELOPMENT AT THE U.S. GEOLOGICAL SURVEY

CALLAHAN, George M., USGS, NMD, 525 National Center, Reston, Virginia 22092

The National Mapping Division of the U.S. Geological Survey (USGS) has begun a major new system development effort called Mark II that will implement advanced technologies and production procedures to satisfy National Mapping Program requirements through the year 2000. By 2000, the National Digital Cartographic Data Base (NDCDB) should contain digital data representing the content of primary map series and other smaller scale series. This data base will serve two major functions-- as a central archive for the dissemination of digital data and as a working data base for production of standard USGS graphic products.

To accomplish this ambitious data-base goal, a series of development tasks are being implemented to (1) expand and improve mass digitization capabilities, (2) modify data structures to support increased content and access requirements, (3) develop digital revision capability, (4) develop product generation capability for standard, derivative, and digital products, (5) improve quality control, and (6) support advanced analysis and applications.

To evaluate the existing systems and to facilitate the identification of new and improved capabilities, Mark II was divided into four functional components, each addressing a specific portion of the production process.

The data production component addresses all phases of data collection, editing, data processing, and quality control prior to entry into NDCDB. The data-base component is designed to develop two levels of data bases: (1) an operational data base to support ongoing mapping center production, and (2) an archival data base to provide a central repository for data to support the operational data bases. The product generation component is designed to produce the cartographic products required to support the National Mapping Program. The production management component is designed primarily as an interface between the Mark II production system and the National Mapping Program production requirements and authorization systems.

Implementation of both digital revision and maintenance of primary quadrangle mapping through digital techniques will produce major changes in the National Mapping Program production process. A production strategy was developed to meet the Mark II goals, but the strategy was constrained by anticipated resources and staffing levels, anticipated user requirements, and limitations imposed by developmental activities.

ILLUSTRATION CAPABILITIES OF A COMPUTER GRAPHICS SYSTEM

CALLAHAN, J.L., USGS, WRD, 300 W. Congress St., Federal Bldg., FB-44, Tucson, AZ 85701

In 1989, the Arizona District of the U.S. Geological Survey began using a computer graphics system for illustration design consisting of an Apple Macintosh II with 5 megabyte random-access memory, 40 megabyte hard-disk drive, 13-inch high-resolution color monitor, Apple Laser Writer II NT Postscript printer, and Dest PC scanner. Adobe Illustrator 88 is the primary software used on the system. Other software used includes Cricket Graph, Aldus Pagemaker, Publish Pack, and Adobe Streamline.

Flexibilty of the system permits rapid and accurate preparation of maps, graphs, and diagrams and easy accommodation of review comments. Author-supplied computer graphics or rough conceptual sketches can be brought to the system and modified to conform to U.S. Geological Survey publication standards and page-size requirements. The system has been used successfully to produce documents that can be converted into slides. In addition to an improvement in the final product, the use of the system has increased productivity and decreased the time the author spends drafting figures.

THE DEVELOPMENT OF A GEOGRAPHIC AND USER-ORIENTED SYSTEM FOR ACCESSING
INFORMATION IN THE NATIONAL WATER DATA EXCHANGE DATA BASE

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Portland, OR 97216; PARKS, Bruce, USGS, WRD, 417 National Center,
Reston, VA 22092

The National Water Data Exchange (NAWDEX) was established to function as
a clearinghouse to assist in processing public requests for water-
resource information. The NAWDEX system resides at the U.S. Geological
Survey headquarters office in Reston, Virginia, on an Amdahl computer
and has been in operation since the mid 1970s. The NAWDEX data base
contains information on almost one-half million sites throughout the
United States and Puerto Rico. Nineteen Federal and more than 300 State
and local agencies contribute information to NAWDEX.

A geographic information system was interfaced to the NAWDEX system
in 1989 because there was a need for a spatial and user-oriented access
system to the NAWDEX data base. The prototype geographic-information-
system design allows users to retrieve or display information at sites
specified by the user through the use of on-screen menus and maps.
Through the use of these menus, the user can select NAWDEX sites on the
basis of spatial location and (or) some other specified criteria,
perform frequency analysis on the data items associated with the sites,
and then select a subset of the sites on the basis of a smaller area or
a more limited set of criteria. In addition, digitized maps can be
saved as plot files and can include NAWDEX site location, reference
features, and annotation. Reports for selected site retrievals can
include any number of NAWDEX identifiers and associated items. On-line
help is provided to guide the inexperienced computer and (or) NAWDEX
user. The prototype geographic-information-system design is being
tested at the U.S. Geological Survey office in Portland, Oregon, and may
eventually be available at other NAWDEX centers.

PROCESSING OF BATHYMETRIC DATA FOR PEND OREILLE LAKE, IDAHO

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WOODS, P.F., USGS, WRD, 230 Collins Road, Boise, ID 83702

In late 1988, the U.S. Geological Survey began an investigation of nutrient enrichment in north Idaho's Pend Oreille Lake, the Nation's twenty-first largest (surface area) and fifth deepest freshwater lake. Objectives of the 3-year investigation include quantification of hydrologic and nutrient budgets, characterization of limnology, and development of a computer-based nutrient load/lake response model. Water-resource managers will use the model to simulate limnological responses to alterations in the quantity of nutrients received by Pend Oreille Lake.

Extensive use has been made of geographic information system tools and techniques because this investigation requires detailed hydrologic and water-quality data from numerous subbasins within the 24,000 square-mile study area, as well as depth-layered limnological data from the 170 square-mile lake. One example of the use of geographic information system tools is the processing and display of bathymetric data for use in the model. A major attribute of the model is the ability to simulate water quality for several hydrologically connected spatial segments instead of for a single water body. ARC/INFO was used to compute volumes and surface areas of numerous depth layers within each spatial segment of Pend Oreille Lake. The model will use the data to compute the mass of nutrients contained in each depth layer of the lake segments.

11

A COMPUTER PROGRAM TO CALCULATE SEDIMENT-DISCHARGE RECORDS

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85730; MCELHONE, Timothy J., USGS, WRD, FB44, 300 W. Congress St.,
Tucson, AZ 85730

Sediment-Record Calculations (SEDCALC), an interactive program, was
developed to facilitate calculations of sediment records. Techniques
used by the U.S. Geological Survey to provide the Nation with sediment
data have not changed substantially for almost 50 years. The program
is a compilation of programs developed independently by several
district offices of the U.S. Geological Survey to meet their respective
computational needs and to minimize the intensive labor associated with
sediment-record calculations.

The stand-alone program accepts unit or daily discharge data either
from the Automatic Data Processing System, which is a subsystem of the
National Water Information System or from an external file. Suspended-
sediment concentration data are obtained from either the Quality of
Water Data subsystem of the National Water Information System or an
external file. Unit values of suspended sediment may be obtained by
any or all of the following methods:

1. By digitizing a manually drawn suspended-sediment concentration
   trace for input to the program.
2. By linear interpolation and (or) extrapolation with suspended-
   sediment concentration data.
3. By nonlinear interpolation using a quasi-hermite spline function
   from the IMSL[1] library that approximates a hand-drawn curve.
4. By simple or multiple linear regression (transport curve).

Suspended-sediment load is calculated and then stored in unit and daily
value files.

The program has options for calculating daily total sediment loads.
Plots and tables of data and calculated loads can be generated from
the program. Discharge and sediment data from the external files can
be loaded into the Automatic Data Processing System unit or daily value
files for permanent storage.

The program also can be used to estimate periods of missing record
and can be used for estimating historic sediment-discharge data.
Records calculated from linear, nonlinear, and regression techniques to
estimate sediment concentrations need to be compared to traditionally
calculated records to evaluate the adequacy of these automated
techniques in sediment-record calculations.

A METHOD FOR EVALUATING POTENTIAL WATER-SUPPLY-WELL SITES BY USE OF A GEOGRAPHIC INFORMATION SYSTEM

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Evaluation of factors that affect the selection of potential public-water-supply-well sites for features such as ground-water quality and quantity requires the analysis of large volumes of hydrogeologic and water-quality data, which typically are in map and tabular form. Compiling and reviewing these data can be time-consuming and tedious. In 1988 the U.S. Geological Survey, in cooperation with the New York State Department of Environmental Conservation, designed, constructed, and evaluated a geographic information system data base to manage and analyze data pertinent to potential well sites within a 166-square-mile pilot study area on eastern Long Island, New York. To describe ground-water conditions around a potential site, 27 data layers consisting of hydrogeologic and water-quality information were entered into the geographic information system. Well-siting criteria supplied by the Department of Environmental Conservation were reviewed, and the two most important measures of site suitability were identified: (1) proximity of the proposed site to features that may affect the quality and (or) quantity of available ground water, such as hazardous-waste sites and existing public supply wells, and (2) hydrogeologic and water-quality characteristics beneath and surrounding the proposed site, such as water-transmitting properties and results of ground-water nitrate analyses. A series of computer programs was developed to provide a menu-driven, user-friendly interface to access these data and enable users unfamiliar with the geographic information system to extract stored data and display spatial relations among multiple data layers. The geographic-information-system software and the computer programs have demonstrated their utility in increasing the efficiency of well-siting evaluation procedures.

CONSOLIDATION AND UPGRADE OF THE DISTRIBUTED INFORMATION SYSTEM OF THE U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

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From 1982 through 1987, the U.S. Geological Survey, Water Resources Division (WRD), implemented a Distributed Information System and installed 71 large minicomputers in Survey offices across the United States to support its mission of making public the results of its hydrologic investigations. These minicomputers are moderately-sized computers that are used by multiple users interactively as compared to personal computers that are small and are used only by single users, and to the large, mainframe computers that generally are operated on a batch job basis. The computers consisted of Prime 50 series Central Processing Units (CPUs) that ranged from 1 to 5 million instructions per second in processing capability, 8 to 32 megabytes in memory, and from 1,200 to about 4,800 megabytes in disk storage. These computers are linked through a wide-area telecommunications network that permits information to be shared among the computers in each office.

In 1988, the Division implemented a consolidation plan to allow multiple minicomputer-system sites to upgrade the processing capability, memory, and storage of their systems. Although the consolidation plan resulted in sites having fewer minicomputers, their overall capability was significantly increased. The upgraded Distributed Information System consists of Central Processing Units that range from 1 to 23 million instructions per second in processing capability, 8 to 48 megabytes in memory and from about 1,500 to 13,000 megabytes in disk storage; the total number of minicomputers in the Distributed Information System was reduced from a total of 71 to 55.

EVOLUTION OF A MICROCOMPUTER-BASED LOCAL AREA NETWORK FOR REPORTS PROCESSING

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The Water Resources Division, Publications Management Unit (PMU), of the U.S. Geological Survey National Center in Reston, Virginia has implemented a microcomputer-based local area network (LAN). The network was established to centralize and to enable cost-effective sharing of word processing capabilities, budgeting operations, and printers among office personnel. The network contains Disk Operating System local area network software, an 80386-based microcomputer server, 80286-based microcomputers designated as workstations that access the server, and a shared laser printer. Each microcomputer on the network is connected through communications boards to thick Ethernet coax cable.

Software is installed on the microcomputer designated as the server to provide resource sharing, storage of applications programs, and files that perform activities requested by the users. Software installed on the workstations allows users to request applications programs and files from the server for processing. After installation, the LAN software allows the network administrator to register users, organize directories and files on the server's hard disk, and permit workstations to access assigned printers connected to the server.

Distributed Information System-II, the Water Resources Division's new 32-bit super-microcomputer network, will be based on the Unix operating system which uses transaction control protocol/internet protocol (TCP/IP). The data communications protocol of the current network in PMU uses Xerox Network Services (XNS). Therefore, the basic communication protocols of the PMU network and Unix are incompatible. A cost effective solution is to abandon PMU's current LAN and convert to a network file system based personal computer software package. The network file system software establishes a communications link between the microcomputer workstations and Unix and provides access to both Disk Operating System and Unix applications.

A PROCEDURE FOR CHOOSING CLASS INTERVALS FOR COUNTY CHOROPLETH MAPS

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A new procedure for displaying pesticide-use data by county was needed because presentation of the data in tabular form did not communicate the spatial distribution of pesticide applications. Choropleth maps that used class intervals chosen such that equal numbers of counties fell into each class did not permit ready comparison of the different pesticides because different class intervals resulted for each map.

A procedure that would allow the maps to be used as an analytical tool in examining the spatial distribution of pesticide use was sought. A procedure was developed to account for both the intensity of pesticide use within individual counties and the relative contribution of use in each county to the total amount applied in all counties. The procedure ranks the counties in descending order of amount of use, then assigns the counties to class intervals based on the percentage of total cumulative use. Initially devised for pesticide-use data, the procedure has been generalized to apply to other types of data, such as water-use estimates. The procedure is currently (1990) being implemented in an automated geographic information system, ARC/INFO, but the software could be modified for other programming systems.

USING AN AUTOMATED GEOGRAPHIC INFORMATION SYSTEM TO PRODUCE
GRAPHICS FOR A PAGE DESCRIPTION LANGUAGE

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The automated geographic information system, ARC/INFO, contains a
"PostScript post-processor," which is software that converts
Calcomp plot files to PostScript page-description language. The
resulting PostScript code can produce graphics on any PostScript-
compatible device ranging from low-resolution 300 dot-per-inch
laser printers to high-resolution publication-quality devices,
such as the Linotype L300. A tutorial that describes the use of
the geographic information system and the post-processor software
has been prepared. The tutorial describes how to generate a
Calcomp plot file that can be converted to PostScript; how to set
up a table for translating the symbols in a Calcomp plot file to
lines, area tints, and text in a PostScript plot file; how to use
the PostScript post-processor to convert a Calcomp plot file to
PostScript code; and how to output the PostScript code to several
hard copy devices.

USING A STATISTICAL ANALYSIS SYSTEM AS A GEOGRAPHIC INFORMATION SYSTEM

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The Statistical Analysis System, SAS (SAS is a registered trademark of the SAS Institute Inc., Cary, N.C.) has long been used by administrators and scientists throughout the U.S. Geological Survey for statistical and mathematical data analysis, applications development, report writing, and presentation graphics. This software system runs in a variety of computer environments: mainframe, minicomputers, and microcomputers.

Graphic capabilities of this software system can be used to provide powerful mapping features which can be used in confunction with other capabilities of this system such as data management, file manipulation and merging, statistics/mathematics, gridding, and three-dimensional portrayal to simulate functions that are found in full-fledged geographic information systems. Such functions can be especially useful for spatial data analysis, exploration, and transformation. Outputs from such functions of the statistical system can be used for direct input to other powerful GIS-specific software systems which are available in USGS geographic information system laboratories.

Projects of the Information Systems Division of the U.S. Geological Survey have used this statistical analysis system as a tool in the collection, management, analysis, and display of spatially referenced data. In this sense, the statistical analysis system has been used to assist in automating the manual process of gathering and analyzing a wide variety of data needed to make land-use and resource management decisions and solve earth-science problems.......the traditional definition of GIS.

Some of the statistical analysis system functions are: (1) storing digitized spatial data; (2) computing spatial statistics and statistically/mathematically transforming data; (3) combining and overlaying multiple layers of spatial data; (4) operating upon vector and raster data; (5) gridding and multiple methods for interpolating surface response data; and (6) producing line, chloropleth, contour maps, and other geographic representations, such as three-dimensional perspectives.

DIGITIZING TIME-SERIES DATA FROM CONTINUOUS-RECORD CHARTS

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In hydrologic data collection, there is a continuing need for the use of continuous strip-chart recorders in field applications. Manual reduction of data from these charts is tedious and prone to error, and typically does not extract all available information from the paper record.

A flexible, interactive computer program has been developed that allows digitizing and storing of data from time-series charts for further processing. A Fortran program called STRIP is used with the common configuration of a Prime computer and an Altek digitizing table in eavesdrop mode. Output produced by the program includes unit-values data, in standard card images, and a summary of daily information, such as noon value, peak value, and time of peak. The time interval for unit values can range from 1 minute to 4 hours. The program is coded as a set of subroutines that have been used as the basis for other computer algorithms involving digitized input or time-series data. The program has been extensively tested and already is used in many Survey offices for reducing strip-chart data of ground-water levels and sediment records.

Many features have been incorporated into the program to address the difficulties of data reduction from paper charts. Date and time are automatically adjusted to correct for fast or slow clockwork or paper distortion. Interpolation and sorting routines allow the user to enter as many or as few points as deemed necessary, in any order. The program recognizes and adjusts for the different Altek output formats, and can be easily modified for other digitizer formats. The user can back delete unwanted data points. Complications such as gaps in the record, scale reversals, multiple wrap-arounds, and other unusual or changing scales can be handled easily.

INTEGRATED APPROACH TO DEVELOPING DIGITAL DATA BASES FOR STREAM
NETWORKS AND DRAINAGE BASINS

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In water-resources investigations conducted by the U.S. Geological
Survey, there is a need for detailed, standardized, digital data bases
of stream networks and drainage basins of the United States. These
data bases would be useful for every facet of surface-water
investigations, yet no national program or guidelines have emerged.
Digital line graph hydrography at 1:100,000 scale (100K DLG) contains
much information, but requires processing, simplification, and
attribute coding to reach full utility. Digital elevation data
presently are inadequate for automatic generation of detailed basin
boundaries over large areas due to incomplete coverage, lack of
precision, occasional inaccuracies, and software limitations. Labor-
intensive methods for digitizing basins, although time consuming, are
reliable and can be designed to maximize both the existing digital
data and the capabilities of the processing software.

In Kentucky, the U.S. Geological Survey is applying an integrated
approach that will result in compatible data layers, or coverages, of
hydrography and drainage basins. A one-to-one correspondence between
hydrography arcs and basin polygons is maintained. First, the 100K
DLG hydrography is processed and edited to produce a "skeleton" set of
arcs that form a simple dendritic pattern. Each stream segment that
is named on the 100K paper map is represented by one arc. This
typically results in about 400 arcs per 30- by 60-minute map. Then
drainage boundaries for each stream segment are delineated on 1:24,000
scale topographic maps and digitized. Drainage boundaries are snapped
to the hydrography so that stream junctions are precisely registered
with basin junctions. Specialized software commands are used to
establish upstream-downstream relations and to group sets of arcs into
larger basin units. Because of the one-to-one correspondence,
attributes can be transferred easily between stream arcs and basin
polygons. An extension of the hydrologic unit numbering system is
planned.

PRELIMINARY COMPARISON OF GROUND-WATER SITE INVENTORY INFORMATION IN
THE U.S. GEOLOGICAL SURVEY'S NATIONAL AND DISTRIBUTED DATA BASES
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As part of an evaluation of the U.S. Geological Survey's ground-water
site inventory information data base, procedures were developed to
compare the National Water Storage and Retrieval data base with the
distributed National Water Information System data bases. Comparison
of the two systems is not straightforward because their retrieved
outputs differ in organization, format, sorting order, and component
numbering. To solve the problem, a set of programs were written using
Prime's Command Programming Language and Fortran. The programs are
easy to use and give the user flexibility regarding sites retrieved
and comparison criteria.

The procedure consists of two major steps, each controlled by a
single Command Programming Language program. The first program
assembles job decks and retrieves ground-water site inventory data
from the National Water Storage and Retrieval data base and the
National Water Information System into separate data files. Because
of limitations on size, several retrievals per state are usually
necessary. A second Command Programming Language program controls the
remaining procedures. The data files are converted to a standard,
compact format, then joined and sorted. The National Water Storage
and Retrieval data base and the National Water Information System data
are handled separately. The two data sets are then compared using a
stepwise method, based on successive matches between site identifier,
component group, sequence number, and component value. The component
values can only be compared if agreement occurs at each preceding
step. A summary of comparisons for each component is produced, along
with a detailed list of discrepancies, which can be used as a basis
for error corrections. Individual summaries of the two data bases are
also produced.

Initial comparisons for five states indicate that the two data
bases differ greatly in the number of sites and components they
contain, but that differences in compared data values are relatively
minor. Inconsistences often seem to reflect systematic differences in
structure, error checking, or data transfer between the two data
bases.

A METHOD FOR DESCRIBING STREAM-DRAINAGE-SYSTEM TOPOLOGY IN A GEOGRAPHIC INFORMATION SYSTEM

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Describing stream-drainage systems in a geographic information system presents special problems and opportunities. Locations on a stream are commonly referenced by distance upstream or downstream from a given point. Although geographic information system software can easily manipulate map data, it stores locations in a Cartesian coordinate system rather than as distances along a path. The concept of dendrite topology was developed as a link between existing methods and the extraction of information about a stream system and its related basin characteristics.

The term dendritic describes the structure of a tree and its branches; dendritic structure can resemble the drainage pattern of a stream and its tributaries. Dendrite topology contains lines and points. The line component consists of a collection of arcs that describe a stream trace--the path that an average particle of water travels from the drainage divide to the mouth or specified end point. The trace is continuous and passes through marshes, lakes, and the midline of wide rivers and braided streams. Each stream trace has a unique identifier. The point component is a single label that identifies the endpoint of a stream trace, normally at its mouth where it joins another stream trace.

Dendrite topology was defined and used to calculate the length and slope of streams in the Redwood River basin in southwestern Minnesota. Known elevation points on the river system were obtained from U.S. Geological Survey 1:24,000-scale topographic maps. These points were identified by the stream identifier and downstream distance. The outlet locations of subbasins within the river system were identified by stream identifier and basin identifier. A computer program was written to calculate the length of the main channel from the headwaters divide to the mouth and to locate points 10 and 85 percent of the distance from the mouth to the headwaters divide. The main channel slope was determined using interpolated elevation data at the 10- and 85-percent-point locations and the previously determined channel length between those points.

HYPERTEXT DOCUMENTATION OF A GEOGRAPHIC INFORMATION SYSTEM

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A hypertext tool was used to document a geographic information system. Hypertext allows non-sequential access to text in a document. Text, such as a word or paragraph, can be connected to text elsewhere within the same or other documents. The use of a mouse to click on the text immediately changes the location of the cursor within a document to that of the connected text. The data sets in the geographic information system being documented contain data that represent relevant geographic features such as wells. These data sets are divided into classifications, such as surface water and ground water. The classifications are listed and briefly described, and hypertext is used to connect the name of each classification to a list of data sets within the classification. Likewise, the name of each data set is connected to a data dictionary for the data set. If a data set is logically included in more than one classification, the hypertext document can reflect this by including the name of the data set in each appropriate classification and connecting each name to a single data dictionary. This allows data sets to be documented in a way that minimizes redundancy of both documentation and data, and, at the same time, provides a flexible method to search for data sets in the database. A hypertext index that lists the name of each classification, subclassification, and data set is also provided. Each name is directly connected to the appropriate page in the document. This allows users who are familiar with the database to directly access data set documentation without searching through each classification and subclassification.

TRANSFERRING COMPUTER PROGRAMS BETWEEN DIFFERENT COMPUTERS

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After the award of the Distributed Information System-II (DIS-II) contract, current Formula Translation (Fortran) programs may need to be revised to be compatible with the new Distributed Information System-II computers and compilers. This paper identifies some of the problems, solutions, and steps to minimize problems when a computer program is transferred to another computer.

One problem occurs when the original programmer assumes that the compiler is going to implement Fortran statement(s) in a particular way. An example is expecting variables local to a subroutine to retain the last value assigned when reentering the subroutine. Assumptions such as this may not be valid for all Fortran compilers. To fix this type of problem, the programmer needs to search for places in the program where the problem is likely to occur, and modify the program to assume only implementation details specified in the Fortran standard.

The easiest type of problem to locate in a program probably is syntax that does not conform to the American National Standards Institute (ANSI) Fortran standard. Language extensions commonly cause syntax errors when compiling with different compilers. To fix these problems, the programmer needs to rewrite these constructs using only statements that conform to the ANSI Fortran standard. Many of these problems may be detected and fixed by using the ANSI switches, such as Prime's -STANDARD switch. These switches instruct the compiler to print messages when it detects statements that do not conform to the ANSI standard.

Differing word size and number representations for computers and compilers may cause transferred programs to produce incorrect results. A computer might not be capable of representing a number that is calculated or the differing accuracy of number representation can cause high truncation error. The program might run successfully, but produce different or incorrect results. A solution could be to increase the precision of some of the variables.

Whether a new Distributed Information System-II workstation is available or not, the conversion effort can be started immediately by ensuring that Fortran programs conform to the ANSI standard.

SOFTWARE QUALITY ASSURANCE IN THE NATIONAL WATER INFORMATION SYSTEM
PROGRAM OF THE U.S. GEOLOGICAL SURVEY

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The U.S. Geological Survey's water data-processing computer software
systems are developed and maintained by the National Water Information
System (NWIS) Program of the Water Resources Division (WRD). The
system is currently being redesigned for use on 32-bit microprocessors
(workstations) and file servers to be located in WRD offices across the
Nation. A software life cycle provides the framework for guiding and
accomplishing the development.

Software quality assurance is a planned and systematic pattern of
all actions necessary to provide confidence that the software conforms
to established technical requirements. The software quality assurance
program focuses on the establishment of standards, reviews, testing,
and software configuration management procedures throughout the
software development life cycle. Software quality assurance depends
on uniform terminology and communication among users, developers, and
managers. This paper explains the implementation of software quality
assurance and quality control in the NWIS.

USE OF A GEOGRAPHICAL INFORMATION SYSTEM TO INTEGRATE AND ANALYZE MULTIPLE GROUND-WATER DATA BASES

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A large ground-water quality data base for the nematicide 1,2-dibromoethane (EDB) was used to evaluate methods for regional water-quality assessment as part of the U.S. Geological Survey pilot National Water-Quality Assessment Program. Two methods of study were used in an effort to understand the factors affecting the EDB contamination of ground water. In four regional-scale study areas of 50 to 200 square kilometers, the occurrence of EDB in ground water was statistically related to potential controlling factors. Concurrently, a mass-balance modeling approach was used to study the transport and fate of EDB in the subsurface at a local scale of less than 2 square kilometers.

A Geographical Information System (GIS) was used to integrate the EDB data base containing information from a ground-water sampling network of more than 5,000 wells with other spatial data bases within the study areas. The integrated data base has more than 80 descriptive items. The GIS (ARC/INFO) was used to quantify potential factors affecting ground-water quality. For example, digital data were used to determine depth to the water table and distance from EDB application sites to wells. Physical and chemical properties of soils underlying application sites were determined by using digital soil data. The depth of specific soil horizons and the areal extent of soil units within EDB application sites were used to calculate weighted mean soil characteristics. GIS routines were used to determine the aquifer sampled by individual wells and to obtain subsamples of wells that are not correlated. Base maps, figures, and slides for technical papers and presentations were also made with the assistance of GIS.

WATER-BUDGET AND REMOTE-SENSING TECHNOLOGIES COMBINE TO ACCOUNT FOR WATER USE ALONG THE LOWER COLORADO RIVER

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The Lower Colorado River Accounting System (LCRAS) combines hydrologic water budgets, digital-image analysis of satellite data, and geographic information system technologies to quantify consumptive use of water from the lower Colorado River. A regional water-budget approach is the basis for a system by which annual consumptive use of river water can be estimated within the 12,500-square-mile study area. Analysis of satellite data provides vegetation types and associated acreages. The acreages multiplied by water-use rates give estimates of evapotranspiration. The boundaries of each user's area are delineated, digitized, and entered in a data base by using geographic information system software to obtain the spatial distribution of consumptive use.

LCRAS is a modular computer program designed to process the large quantities of data and to combine the output from water budgets with the output from digital-image analysis. LCRAS was designed for (1) annual accounting but can also be operated as a planning tool, and (2) easy modification as new data, software, and improved techniques become available. Within LCRAS, annual consumptive use of lower Colorado River water by vegetation is estimated with water budgets and distributed areally by using estimates of evapotranspiration calculated for each diverter from image analysis and digitized boundaries. LCRAS also accounts for evaporation from open-water areas and for domestic, municipal, and industrial consumptive use. LCRAS contains a single-reach option and a four-reach option that are used to estimate and distribute consumptive use to water users in the 320-mile reach between Hoover Dam and Morelos Dam. The single-reach option provides data for the entire flood-plain area, and the four-reach option provides data for the four subreaches. Water-data inputs to the program are selected to reflect the different hydrologic conditions in each individual subreach of the lower Colorado River.

INTEGRATING THE FEDERAL WATER DATA COORDINATION PROGRAM WITH THE NEW
NATIONAL WATER INFORMATION SYSTEM PROGRAM

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Recent legislation and changing priorities in such environmental
activities as waste disposal and clean-water production have created a
need for additional water-resources information. New technology is
improving the ability to collect, process, archive, and disseminate
water-resources information. The U.S. Geological Survey (USGS), through
the National Water Data Exchange and the Water Resources Scientific
Information Center, provides users outside the USGS with water-resources
information from the Water Data Storage and Retrieval System, the Master
Water Data Index, the Water Data Sources Directory, and the
Environmental Protection Agency's STORET system. With the establishment
of a national water information clearinghouse within USGS, the USGS is
expected to have an expanded role not only in collecting, archiving, and
disseminating its own data, but also in providing information about data
collected by other Federal and non-Federal organizations.

In 1964, the Office of Management and Budget assigned to the
Department of the Interior the lead responsibility for coordinating
Federal activities in the acquisition and sharing of water-resources
information. This includes, among other responsibilities, acquiring,
indexing, and disseminating information on the water-resources data and
activities of all Federal and non-Federal organizations. The Department
delegated its leadership role to the USGS. Within the USGS, this
delegation was extended to District and Regional offices of the Water
Resources Division for leadership and coordination within their
geographic areas of responsibilities. The USGS is not the repository
for data collected by other agencies, but does have a responsibility for
maintaining and disseminating information about other groups' data.

The new National Water Information System being developed by the USGS
will integrate the existing centralized data system of the Water Data
Storage and Retrieval System, the National Water Date Exchange, and the
National Water-Use Information Program. In implementing the new system,
the USGS needs to ensure that it addresses two objectives: 1) it needs
to be able to compile, process, archive, and disseminate data collected
through USGS programs; and 2) it needs to provide access to those data,
as well as to information about water-resources data collected by other
Federal and non-Federal agencies.

DISTRIBUTED INFORMATION SYSTEM-II TRAINING FOR THE U.S. GEOLOGICAL
SURVEY
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The U.S. Geological Survey's Distributed Information System Program
Office will be responsible for coordinating training activities for the
hardware and software that will be used in DIS-II, the second generation
of the System. Courses will include System Administration, Programming,
Data Base Management, Spreadsheet, Graphics, Windowing Tools, Illustra-
tion Software, Electronic Report Processing, Computer Security, and
others. A Training Plan will explain how instructors will be selected
and how the classes will be announced. A Training Course Schedule will
contain course descriptions and schedules, training locations, and
registration procedures. Training services will include video-based and
(or) computer-based training, a reference library, and training
administration.

ARCHIVING ON-LINE DATA TO OPTICAL DISK

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The U.S. Geological Survey has stored instantaneous values of hydrologic data (unit values) on minicomputers since 1985. A substantial amount of disk storage is required for the on-line storage of these data. Traditionally, these data have been archived on magnetic tape to make disk storage space available for additional data. However, magnetic tapes have a limited shelf life, and retrieval of data for a specific site is cumbersome. As the volume of unit-value data to be archived has expanded, the need for a more efficient method for data storage and retrieval has increased.

The Geological Survey's Distributed Information System Program Office is currently (1990) assessing optical disk storage as an alternative means of archiving unit-value data. Optical disks have a longer shelf life than magnetic tapes, and retrieval of archived data is substantially easier. The cost for data storage on write-once/read-many optical disks is comparable to that of magnetic tape and only a fraction of the cost for magnetic disk data storage.

In a test study, unit-value data will be archived using one optical disk drive connected to a microcomputer and a second drive connected to a minicomputer. The cost of data storage, alternative forms of data storage, and specifications for data retrieval will be described.

USE OF A GEOGRAPHIC INFORMATION SYSTEM TO IMPROVE LOCATION DATA IN A NATIONAL POLLUTANT DISCHARGE DATA BASE

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The U.S. Environmental Protection Agency's national data base for permitted wastewater discharges, known as the Permit Compliance System (PCS), is being used in a water-quality-modeling study in New Jersey. The PCS contains information on each permitted discharge, such as permit number, name, location (geographic coordinates), and discharge quantity and quality. The modeling effort requires accurate location data for all wastewater discharges, but preliminary analysis indicated that the data base contains locations for only 983 of the approximately 1,200 discharges permitted in the State. Additional spot checks revealed that some of these locations were inaccurate.

In order to evaluate the quality of the location data, community names recorded in the PCS were matched with entries in the U.S. Geological Survey's Geographic Names data base--a tabular data file of names of cultural and natural geographic features--by using relational data-base techniques and manual comparison of files. A geographic information system (GIS) was used to overlay the locations derived from both data bases with municipal boundary polygon data. For both sets of locations, this overlay operation resulted in the assignment of the municipal code of an overlying polygon to each discharge. Subsequent comparison of the two municipal codes associated with each discharge showed that municipal codes matched for 647 of the 983 discharges. If the municipal codes did not match, location information was obtained from other sources.

The results of the study indicate that (1) regional water-quality studies require more accurate location information for sources of contamination than commonly is available in national data bases, such as the PCS; and (2) a GIS can be used effectively both to evaluate the overall accuracy of a spatial data set and to identify individual records with poor spatial accuracy.

USE OF REMOTE-SENSING DATA TO MAP IRRIGATED CROPS IN SOUTH-CENTRAL TEXAS

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The U.S. Geological Survey, in cooperation with the Edwards Underground Water District, is adapting a classification technique that uses remote-sensing data to map and calculate the areas of irrigated crops by county in south-central Texas. The time and cost of obtaining this information by field reconnaissance is prohibitive; sources from which the information was obtained in the past are no longer available.

Landsat digital satellite images for March and July 1989 were combined and classified to identify the areas of irrigated crops. Normalized difference was used to discriminate vegetation from nonvegetative ground cover because it is more sensitive to the sparse vegetation cover in March than are band ratios, which have been used in previous applications of this technique. Maximum likelihood was the unsupervised classifier. The digital-image classification was calibrated by crop distribution data collected during field reconnaissance in part of the irrigated area in July 1989. Boundaries of the areas irrigated with water from the Edwards aquifer were drafted onto maps, digitized, and registered to the classified image to separate the irrigated areas from the rest of the image and to calculate the number of acres of each crop in each area.

The principal crops classified for 1989 were corn (33 percent of the total irrigated area), cotton (21 percent), and alfalfa grown for hay (6 percent). The rest of the total irrigated area, to which water was not applied in 1989, consisted of fallow and idle fields (29 percent), mixed-grass pasture (9 percent), and unidentified vegetation (2 percent). Uvalde County had the largest total area irrigated with water from the Edwards aquifer (93,000 acres) and Bexar County had the smallest area (2,800 acres).

A COMPUTER PROGRAM TO DETERMINE MAP COORDINATES FROM PUBLIC LAND-SURVEY COORDINATES

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Site locations in many states may be described using "local numbers" derived from the township, range, and section designations of the U.S. Public Land-Survey System. Where Public Land-Survey boundaries are available on topographic maps, local numbers generally are easier to determine than latitude and longitude. Many data bases maintained by federal and other agencies report location only by local numbers. Because the Public Land-Survey System is based on an irregular gridding system it can be difficult to translate local numbers directly into geographic coordinates for mapping and analysis.

A Fortran program was written to transform local numbers into a specified map coordinate system. The program uses proprietary ARC/INFO Geographic Information System subroutine calls and extracts map coordinates for the corners of the section of interest from computerized map data. The section is subdivided into quarter-sections, then each quarter-section is subdivided into quarters -- to a maximum of four levels of subdivision. Then, the map coordinates at the center of the subsection are computed by interpolation. Optionally, a file containing a set of alternate coordinates such as latitude and longitude can be read. The program can calculate the distance between the computed coordinates and alternate coordinates and determine if the distance is greater than acceptable limits.

The program can be used to check for errors in the locations of sites stored in the Geological Survey's data bases. Latitude-longitudes have been compared with local numbers for over 1,000 sites in Oklahoma, revealing a number of errors or inconsistencies in coordinate data that had been hand-checked several times. The program has also been used to identify irregularly-shaped sections in computerized maps.

AN INTERACTIVE COMPUTER PROGRAM, GWARC, TO CREATE A GEOGRAPHIC
INFORMATION SYSTEM DATA SET FROM GROUND-WATER SITE INVENTORY DATA
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A computer program, GWARC, was developed to interface data from the
Ground-Water Site Inventory subsystem of the U.S. Geological Survey's
National Water Information System with the geographic information
system, ARC/INFO. The program, GWARC, was designed to graphically
display the information retrieved from the Ground-Water Site Inventory
data base. The program is menu-driven and designed for users with
limited background on use of geographic information systems. The
program has the capabilities to retrieve Ground-Water Site Inventory
data, read the output files, and manipulate the information to produce
an ARC/INFO point-coverage file of spatially distributed data points.
The program then merges the point-coverage file with an existing digital
map-coverage file and produces a plot file that can be input to a
variety of graphical devices. The program was written for the Prime
Series 50 minicomputers and combines Fortran 77, Prime's Command
Procedure Language, and ARC Macro Language subroutines. With minor
modifications, GWARC can be implemented in other computer systems.

NATIONAL WATER CONDITIONS, A PERIODICAL PUBLISHED BY THE U.S. GEOLOGICAL SURVEY

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The National Water Conditions (NWC) is a monthly periodical published by the U.S. Geological Survey, in cooperation with Canada's Department of the Environment, Water Resources Branch, since October 1944. The switch from a Multics computer data base to a Prime minicomputer data base was begun in summer 1985. Since then, the NWC and its reporting system have undergone many changes, including the transition from a cut-and-paste document to a desk-top electronic-report document. The transition has been difficult at times but rewarding because of the current ability to process and present hydrologic data in tables, maps, and graphics for use by the NWC staff in preparing the NWC, in the NWC itself, and also for use in briefings, both within and outside the U.S. Geological Survey. NWC products range from the hard copy of the NWC itself to video presentations and computer presentations in both Microsoft disk-operating system and Apple formats. The future can only bring more change in the process as used to prepare the periodical and the periodical itself.

THE SPATIAL DATA TRANSFER STANDARD

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The success of any standard depends on acceptance by the community of
potential users. Accordingly, the process coordinated by the U.S.
Geological Survey to develop a spatial data transfer standard for use
by Federal agencies and the earth science professions was tailored to
involve all segments of the profession, including Federal agencies
involved in mapping, private industry, and the academic community.
This development effort has been difficult and time consuming; however,
with a broad base of involvement by a wide range of organizations, a
final standard has been produced that will be a significant benefit to
users of spatial data.
   The development of the standard has been under the direction of a
Spatial Data Transfer Standard Technical Review Board. This board was
given the responsibility to complete the Spatial Data Transfer Standard
for promotion to the National Institute of Standards and Technology as
a Federal Information Processing Standard. The board has done a
successful job in finalizing the standard by putting together a
document that meets the needs of the community and yet is not too
complex.
   In support of the Spatial Data Transfer Standard, the U.S.
Geological Survey will coordinate the development of a suite of
software tools to assist users in interfacing with the standard. The
availability of user-friendly software support tools is considered to
be a critical element that will enhance the promotion of the standard
and secure its acceptance throughout the community.

USING MICROCOMPUTER GRAPHICS TECHNOLOGY AS AN AID IN THE PRESENTATION OF GEOGRAPHIC INFORMATION SYSTEMS PROJECTS

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Geographic Information Systems (GIS) project presentations away from the office have been difficult in the past because of specific hardware, software, and communications requirements. However, by using the combination of microcomputer graphic arts software and a variety of output devises, it is possible to manipulate and enhance images of spatial data sets. This provides various types of transportable presentation media.

Postscript printers will provide gray-scale publication-quality illustrations. High-resolution color-image copiers can be used to produce high-quality paper and transparency hard copies. Transparencies can be used further to create color separates of an image that when combined with photographic processes, produce color posters. Other photographic techniques include the use of film recorders that can produce 35-millimeter slides, 4- by 5-inch or 8- by 10-inch negatives. A series of images can be output to video recording devices to provide the user with a video taped presentation, making it possible to demonstrate GIS projects using only a television and video cassette recorder.

ANALYSIS AND PRESENTATION OF GEOPHYSICAL DATA USING A COMPUTER PROGRAM

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A commercially available computer program known as Surface III generates surfaces from irregularly spaced X-Y-Z data and allows easy manipulation, spatial analysis, and display of those surfaces. One principal use of the program is to display and manipulate geo-physical data, such as aeromagnetic and gravity fields. The program is especially useful for large regional studies such as the recently completed studies of carbonate-rock aquifers in southern Nevada and Carson Basin National Water-Quality Assessment Program. Plotting of color-shaded contour maps allows an effective method of data presentation as simple contours are often hard to interpret easily.

This computer program is also capable of manipulating large data sets to facilitate data analysis. It reads free-format or user-selected format data files. Various statistical routines are available within the program to detect possible incorrect data values such as a value that differs markedly from the norm. A histogram can be specified for the data set to allow the user to determine quickly the distribution of data and, therefore, the appropriate contour intervals or color bands.

Contour maps can be prepared quickly by using default options that are useful for cursory inspection of the data before a more complex map is constructed. The program draws isometric or perspective and stereo views of the data. This is also a useful technique for viewing the data, especially if the data contain a high-frequency noise component. Highs and lows are readily apparent in relation to the rest of the data set.

The graphics routines of the program are linked to two separate plotting libraries that allow maps and plots to be displayed on virtually any plotting device. Sending the plot to a device-independent plot file allows it to be stored for display at a later time, at different scales, or on any supported device without the computer overhead of re-running the program. With simple command structure, many carefully selected default values, and flexibility in producing visually effective maps, the computer program has proven useful for geophysical data interpretation and display.

AUTOMATION OF CAMERA-READY TABLES OF GROUND-WATER SITE INVENTORY
WELLS AND SPRINGS

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The current (1990) Ground-Water Site Inventory tabling program of the
U.S. Geological Survey's National Water Information System does not
produce camera-ready tables suitable for publication. In general,
about 40 hours is required for a typist to prepare a table containing
well or spring information for publication. A computer program was
developed to automate all of the necessary editing and formatting for
creation of data tables.

The program is written in Fortran and exists external to the
Ground-Water Site Inventory system; it addresses (1) the format and
layout of column headings; (2) the components that should appear in
every table; (3) the organization and format (number of significant
digits) of the data; and (4) the value to retrieve for a component
with multiple values. Program output conforms to the style, format,
and publication standards of the U.S. Geological Survey and the
Pennsylvania District with regard to well and spring tables; the
program can be modified for preparing data tables in any format.

The program uses the Ground-Water Site Inventory tabling
program's output to produce an American Standard Code for Information
Interchange file in publication format. U.S. Geological Survey's
publication guidelines require the table to fit on two 8 1/2- by
11-inch facing pages with approximately 1-inch margins. Therefore,
special consideration needs to be given to font selection for the
printer when camera-ready copy is prepared.

IMAGE-PROCESSING CAPABILITIES RELATED TO
WATER-RESOURCES INVESTIGATIONS
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Historically, image processing of satellite data for water-resources
investigations has been used by the U.S. Geological Survey (USGS)
primarily for land-cover classification. The actual processing of
data was frequently performed by another agency with the necessary
expertise and equipment. A few USGS District offices purchased
software and hardware to perform image processing; however, most
Districts lacked the necessary expertise in image processing and
generally could not afford the expense of the software and hardware.
Recently, interest has been renewed in image-processing and analysis
because of the expanding use of geographic information systems,
reduced cost of software and hardware, development of a user-friendly
software interface, and increased knowledge of image-processing
techniques and capabilities by scientists.
    Computer software and hardware systems and other resources are now
available within the USGS for scientists to perform image processing,
integrate image-processing capabilities with geographic information
system and other software used by the Survey, and generate a variety
of output products. Satellite data (before 1984) can be acquired
through the Federally Owned Landsat Data Program. The Science and
Technology Laboratory Applications Software (ELAS), maintained and
distributed by the Stennis Space Center, is designed to analyze and
process digital imagery and non-image data. The software was
installed on USGS Distributed Information System I computers and has
been used by a number of scientists. A major revision of the software
includes an online help system, the capability to create user-defined
menus, and the development of a UNIX version of the software which
would facilitate the use of the software with Distributed Information
System II. Interactive display of image data can be accomplished with
dedicated display devices or other standard graphic interfaces, but a
microcomputer display system is an inexpensive option for viewing
data. Laboratories in the USGS provide plot services that create
scaled photographic and paper products of enhanced imagery.

PRESENTATION COMPUTER GRAPHIC SLIDE SERVICE
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The U.S. Geological Survey, Water Resources Division (WRD), Distributed Information System Program (DIS) office in Reston, Va., provides a computer graphic slide preparation service to all Division employees. Slides can be created from most of the software packages used on the WRD minicomputers. Many employees have taken advantage of this service; more than one thousand 35 millimeter slides were generated in the DIS office during Federal fiscal year 1989. Slides can be created from most of the software packages used on WRD minicomputers. The DIS service is less expensive than commercial slide services. The only charges to the requester are for overnight delivery and slide developing, both of which are optional services.

The DIS Program office suggests basic guidelines for the design of computer files to be generated as effective 35 millimeter slides. These guidelines include editing techniques and style and color consistency.

The request is documented on a Slide Request form that records information such as name, phone number, shipping address, the type (Tel-A-Graf, Arc, Disspla) and number of slides, the date the slides or film are needed, and whether overnight mail service is required. Once the request is initiated, instructions are given for transferring the required files into a designated computer directory on the Reston minicomputer. After the graphics files are received, a turnaround time of one week for undeveloped film, and two weeks for finished slides is required. Finally, electronic mail is sent to the author informing him/her know that the slides have been completed and shipped.

CONFIGURATION AND CONTRACT MANAGEMENT FOR THE DISTRIBUTED INFORMATION SYSTEM-II OF THE U.S. GEOLOGICAL SURVEY

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The Distributed Information System-II (DIS-II) of the U.S. Geological Survey, Water Resources Division will eventually replace current DIS minicomputer systems. This process of transition from DIS to DIS-II is in its early stages of implementation. On the basis of scientific workstation technology and local area communications networks, DIS-II will provide a new generation of computer hardware and software. Distributed workstation processing will help to meet rapidly increasing demand for computing resources. Each site will have its own configuration of DIS-II workstations and supporting devices, which will be powerful enough do allow that office to do most of its work on site, and which will be known collectively as a DIS-II system.

The Distributed Information System Program Office at U.S. Geological Survey Headquarters in Reston, Virginia will have responsibility for the implementation of DIS-II. This office will provide technical expertise and support in the design and configuration of new systems and will assist each site in the analysis and selection of new computer technology to meet the site's current and future computer processing requirements.

The DIS Program Office will be reponsible for all DIS-II contract administration, including advising, ordering, tracking, and managing the procurement, delivery, and acceptance of all DIS-II systems.

IMPLEMENTATION OF A LOCAL AREA NETWORK OF MICROCOMPUTERS TO
COMPLEMENT MINICOMPUTER APPLICATIONS - A STATE OFFICE EXPERIENCE
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The Marlborough, Massachusetts Office of the U.S. Geological
Survy, Water Resources Division, operates a Local Area
Network(LAN) of 17 IBM-compatible and 3 MAC-II microcomputers to
complement software applications used on a remotely located (in
Boston) Prime 6350 minicomputer. Ethernet cabling and Novell
Netware software enable these microcomputers to share costly
peripherals, such as laser printers and high-capacity mass-storage
devices (fixed disk; compact disk-read only(CD-ROM); and write-
once,read-many-times(WORM) drives). Used with the Prime LAN-to-
host controller, this remote site can connect microcomputers
directly to the minicomputer by the Ethernet-based network,
eliminating the need for serial-port connection and asynchronous
file transfer between microcomputer and minicomputer.
Microcomputer applications include word processing, data
assimilation and manipulation, statistical analysis, graphics
display and output, and modeling. The primary benefits of this
approach are faster operation for input/output-dependant software,
such as word processing, reduced storage demands on the
minicomputer, and greater accessibility to a wide variety of high-
quality, relatively low-cost microcomputer software and
peripherals. Implementation of an Ethernet-based LAN has the
secondary benefit of developing skills with Ethernet cabling and
administration of LANs that will be an integral part of the
Survey's Distributed Information System-II at the State-office
level.

MULTIPLE DATA BASE COMPATIBILITY ANALYSIS

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In 1989 a committee was established to review the U.S. Geological
Survey's (USGS) Ground Water Site Inventory (GWSI) data base. Part of
this review involved a determination of the uniqueness of sites
identified in GWSI and an evaluation of the compatibility of ground-
water data stored in GWSI with ground-water data stored in the Survey's
New Site-Specific Water-Use Data System (NEWSWUDS).

Methodology and supporting software were developed to compare GWSI
data to data contained in NEWSWUDS in order to estimate the number of
sites common to both data bases and the number of sites identified in
one data base but missing from the other. Also, sites identified in
GWSI were compared to each other to estimate the number of duplicate
entries.

Sites were compared on the basis of "like" data elements--site
identifier, local well number, latitude/longitude, state code, county
code, hydrologic-unit code, water-use code (primary and secondary), and
permit number. Preprocessing of data was necessary to determine the
proximity of one site to another on the basis of latitude/longitude
(proximity analysis). On the basis of only geographic location, the
proximity analysis provides an initial estimate of which sites are
"duplicates" in the GWSI data base, and which sites are "common" in the
GWSI and NEWSWUDS data bases. A direct comparison of latitude/
longitude for two sites requires an exact numerical equality to indicate
a match. Therefore, in the final evaluation, proximity analysis
estimates of like sites were used instead of numerical comparisons of
latitude/longitude. Prototype applications of these procedures have
been made for GWSI and NEWSWUDS data bases in five USGS Water Resources
Division Districts.

This presentation describes the final data element comparison
process, the scoring algorithm for estimating the likelihood of a match
between two sites, the types of tabular output and summaries provided
by the software, and preliminary results of the prototype applications.
In the prototype applications these procedures seem to be reasonably
accurate in identifying duplicate entries in GWSI and common sites in
GWSI and NEWSWUDS.

COMPARISON OF FOUR PROCEDURES FOR ESTIMATING BASIN AND SUB-BASIN
SLOPES BASED ON A GEOGRAPHIC INFORMATION SYSTEM

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Four methods of calculating mean basin slope and sub-basin slopes
from data in geographic information system coverages were
compared: traditional contour length, modified contour length,
triangulated irregular network, and mean slope curve. The basin
data are contained in four coverages: topography, basin
boundary, sub-basin boundaries, and stream-channel segments.
Data from three small urban basins in Albuquerque, New Mexico
were used in the analyses.

Statistically, there were no significant differences in
results between the methods used to calculate mean basin slope,
but there were significant differences in results between the
methods used to compute mean sub-basin slopes. The traditional
contour-length method and the modified contour-length method were
the easiest to apply to geographic information system analyses.
The traditional contour-length method consistently overestimated
slopes, whereas the modified contour-length method produced
satisfactory results for most slopes. The triangulated irregular
network method produced consistently accurate slopes for all
surfaces, but the procedures were more complicated and used a
large amount of computer processing time and online disk storage.
The mean-slope method was the least applicable to geographic
information system analyses, and the results were similar to the
contour-length method.

Procedures for slope calculations that are based on a
geographic information system are less tedious and more accurate
than conventional procedures. Computational procedures that
previously have been considered too complex can be used rapidly
and efficiently as an analytical procedure based on a geographic
information system.

NATIONAL WATER INFORMATION SYSTEM II SOFTWARE CONFIGURATION MANAGEMENT

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The U.S. Geological Survey is in the process of developing the National Water Information System II (NWIS-II) to integrate and replace the existing hydrologic-data and information systems. The new system is scheduled to be placed into operation by 1992 on a national and local network workstation environment.

Software development phases within the projected life cycle will generate many different system products including source and run code, test procedures, test data, and documentation required to define, develop, and maintain the system. A major challenge facing the development and maintenance of the NWIS-II will be to manage and control system products.

Software configuration management is a method for structuring a life-cycle management product whose primary goal is to maintain control through all of the life-cycle phases. The functions of configuration management are to identify, report, and document problems; establish a working version of the NWIS-II application as a starting point for further development; establish procedures for controlling changes; maintain libraries of all software and documentation developed; monitor problems and enhancements; manage system releases of approved software and documentation; and generate management reports. The objective of software configuration management is to establish formal automated procedures to support and control the NWIS-II life-cycle products.

This paper presents a mangement overview of instituting software configuration management for the National Water Information Systems Program Offices of the U.S. Geological Survey.

USE OF COMPUTER PROGRAMS TO ENHANCE WATER-QUALITY DATA PROCESSING
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Computer programs to aid in the processing and quality assurance as-
pects of water-quality data are being used with increasing frequency
within the U.S. Geological Survey. The Tampa office of the U.S. Geo-
logical Survey processes approximately 2,000 water-quality analyses
each year. Three computer programs--QWRIP.SEG, REVIEW.CPL, and
QWSORT.CPL--were developed to reduce the manual processing and review
of water-quality data. These programs improve quality control by
providing a tracking system for each analysis from initial storage to
final approval and by performing logic tests among selected chemical
constituents. These programs are compatible with the National Water
Information System (NWIS) that operates on the Geological Survey's
network of computers. Each program is a combination of the computer
network's Command Programming Language (CPL) and Fortran.

The first program, QWRIP.SEG, sorts output generated by the water-
quality data entry program (QWSYSTEM) and creates both GOODLIST and
BADLIST files. The GOODLIST file contains analytical results that were
successfully stored in the water-quality data base. The BADLIST file
contains analytical results that were rejected by QWSYSTEM and were not
stored in the water-quality data base. The BADLIST file also contains
data that correspond to the BADQW file generated during data entry
using QWSYSTEM of the NWIS software.

The second program, REVIEW.CPL, performs chemical logic tests and
prints selected historical data from the data base. The chemical logic
tests calculate the percent difference between field and laboratory
values, predict the concentrations of selected ions based on specific
conductance and compares these concentrations with laboratory results,
and list historical data for comparison with new data. The historical
data that can be reviewed using this program includes field-determined
physical and chemical characteristics, chloride and specific conduc-
tance, major ion, and nutrient data. REVIEW.CPL produces a one-page
table for each review category, depending on which characteristics or
constituents are contained in each analysis. The third program,
QWSORT.CPL, combines the output generated by the laboratory, the
GOODLIST file produced by QWRIP.SEG, and the tables produced by
REVIEW.CPL and arranges the output by site identification.

DEFINING THE FUNCTIONAL REQUIREMENTS OF AN INTEGRATED NATIONAL WATER INFORMATION SYSTEM

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The U.S. Geological Survey is designing a second-generation integrated national water information system, NWIS-II. A centralized team, the Integration Team, was formed to analyze and integrate the data and functional requirements defined by eight user groups representing the major scientific disciplines and interests within the Survey's Water Resources Division. This paper will concentrate on the effort to define the functional requirements for the NWIS-II. The Integration Team categorized all the needs specified by the user groups into nine major functional areas: input and edit, data verification, computations, selection criteria for data retrieval, output, system security, data base and software maintenance, project or data section management, and software user interface. Definition of the the major functions involves formal reviews, communications between the Integration Team and the user groups, and the exchange of technical documents that further define and detail users' needs. Refining the functional needs of the NWIS-II is a continuing process.

The NWIS-II, as specified by the user groups, will be in sharp contrast to the first-generation National Water Information System (NWIS). Separate data bases and data management systems for the various scientific disciplines will be replaced by a single integrated system. The users will access the NWIS-II through multiwindowed, multitasking UNIX workstations. The eventual inclusion of a geographic information system capability to the NWIS-II will allow users to retrieve, input, and verify data by spatial-relation characteristics. The use of simple English terminology to query the NWIS-II for data retrievals will be possible. The user groups have specified a system having word-processing capability, including page layout, graphics, statistics, and spreadsheet programs. The user groups also specified a system having the flexibility of defining data input and output formats, computations, and statistical analyses, in addition to the various computational processes for hydrologic data already incorporated into the first NWIS.

Implementation of NWIS-II by 1992 is a realistic goal. Parts of the NWIS-II software will be written by Survey personnel; available commercial software will be used to meet most of the functional requirements specified by the user groups.

A PROGRAM TO DIGITIZE CHARTS HAVING NON-STANDARD COORDINATE SYSTEMS

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DIGIBRIS (DIGItize BRIStol) is a Fortran program developed for digitizing Bristol series 500 and 530 charts. Bristol charts are circular and have a non-standard coordinate system that resembles a polar coordinate system except that the radial lines are arcs of circles, not straight lines. Thus, digitizing a Bristol chart is not a simple polar to rectangular conversion and presents a challenging programming and trigonometric exercise.

In Arizona, Bristol charts are used to record water levels at sites where sediment compaction is being monitored. Reading these charts and manually entering the data into the U. S. Geological Survey surface-water data base is a laborious, repetitive, and error-prone task. The program creates an output file in a standard format suitable for uploading directly into the data base. Using the program to digitize Bristol charts, as opposed to reading and manually entering them, vastly reduces the effort required to enter data into the surface-water data base and also provides improved accuracy.

DEVELOPMENT OF THE NEW NATIONAL WATER INFORMATION SYSTEM OF THE
U.S. GEOLOGICAL SURVEY

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The U.S. Geological Survey, Water Resources Division, is currently
(1990) designing and developing a new version of the National Water
Information System (NWIS-II), which will be distributed across the
Nation on 32-bit microprocessors using dedicated data-line and local-
area-network technology for telecommunications. The NWIS-II will replace
existing systems for the storage, retrieval, and management of water
data--the National Water Data Storage and Retrieval System (WATSTORE),
the National Water Data Exchange System (NAWDEX), the PRlME-based
National Water Information System (NWIS), and the Water-Use Data System.
    Four working groups that were established to address various aspects
of the development of the NWIS-II are as follows: (1) Strategic
Planning, (2) Integration, (3) Users, and (4) Software Quality
Assurance and Configuration Management.
    The Strategic Planning Group provides the overall policy and guidance
for development of NWIS-II. The Integration Group develops the plan for
the data-base structures and processing functions necessary to implement
NWIS-II. The Users Group consists of eight disciplinary subgroups
(Surface Water, Sedimentation, Quality of Water, Biological Systems,
Ground Water, Water Use, NAWDEX, and Spatial Data) that describe the
users' needs and expectations, especially those unique to the discipline,
as well as the processes and constraints for the NWIS-II software
system. The Software Quality Assurance and Configuration Management
Group establishes software standards and guidelines, and coordinates
formal reviews for the continuing development and maintenance of
NWIS-II throughout its life cycle.

DEMONSTRATION OF AN EARTH SCIENCE HYPERMEDIA SYSTEM

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In May 1988, the U.S. Geological Survey established a cooperative program with representatives from the Arctic research community to facilitate data management. One of the key activities that the U.S. Geological Survey has undertaken is membership in the Arctic Environmental Data Directory Working Group, which is sponsored by the Interagency Arctic Research Policy Committee. The working group is composed of representatives from other government agencies and academia. One of the goals of the working group is to facilitate access to earth science data and information for the Arctic and hence improve dissemination. As a first step the working group developed the Arctic Environmental Data Directory, which contains more than 250 references to Arctic data sets maintained by United States Government agencies and other institutions. To meet the data management goals of the Interagency Arctic Research Policy Committee, the working group has undertaken a pilot study, known as the Arctic Data Interactive (ADI), to design an integrated information product that will be published using compact disk read-only-memory (CD ROM) technology. The ADI prototype will include the following multimedia elements:

- Arctic Environmental Data Directory
- Bibliographic information
- Full text of research reports and/or short papers (including illustrations)
- Arctic data sets

The project entails developing a prototype of an electronic journal that includes a mix of textual, numeric, and spatial data and possibly related software for data analysis. The data will be in standard formats to facilitate use with other applications software such as spreadsheets, graphics, and image processing.

The design of the ADI prototype is based on the concept of hypermedia technology. Hypermedia is defined in the computer and information science literature as a software environment for developing non-sequential data-base-management systems. Hypermedia techniques provide the capability to create associative links between structured and unstructured information that may include data, text, graphics, imagery, and sound. Hypermedia systems are also characterized by a user interface that incorporates icons (graphic representations) and multiple windows on a computer monitor. Experimentation with hypermedia technology in this study is an attempt to integrate a broad range of multimedia formats into one product that will facilitate access to Arctic digital data and information.

A TERMINAL-EMULATION PROGRAM (SMTERM) FOR RETRIEVING ELECTRONICALLY COLLECTED DATA ON MINICOMPUTERS

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Use of electronic data storage modules in conjunction with dataloggers provides a reliable and efficient means for on-site, battery-backed data storage and easy transportation of field data back to the office. SM192/721 storage modules, from Campbell Scientific, Inc., use interactive telecommunication commands for data retrieval and, therefore, need to be connected to a telecommunication terminal or a computer that has appropriate telecommunication software.

For use with a U.S. Geological Survey Prime minicomputer, the only suitable telecommunication software available was the Survey's terminal-emulator program called Termem; however, the program did not successfully retrieve all data when using a communication rate of 9,600 baud. Depending on system load, a 1,200 baud rate is usually slow enough so that there is no loss of data; however, a retrieval may take more than an hour. An alternative, which can also be a lengthy operation, is to use proprietary hardware and software that allows data to be unloaded to a microcomputer; the data would then have to be transferred to the minicomputer.

To provide an efficient means for unloading storage-module data directly to the Survey's minicomputer, a storage-module terminal-emulator software utility was developed called Smterm. It is an extensive modification of the Termem program, which uses reverse flow control (reverse XOFF protocol) to prevent overruns of the minicomputer's input queue at any baud rate. Processing time for data retrieval can be shortened by the program's option to disable terminal output during data transfer. It also incorporates special features for automatically (1) establishing the communication link; (2) issuing appropriate commands to retrieve data; and (3) creating an archive copy of the data.

GLOSSARY

2- and 3-card format — An acceptable format for the entry of daily-values data to the Daily Values File that is a part of the USGS Water Data Storage and Retrieval System (WATSTORE) that is located on the AMDAHL main-frame computer in Reston, Virginia. This is also a supported output format in the Automatic Data Processing System (ADAPS), which is a part of the distributed National Water Information System (NWIS) that is installed on PRIME minicomputers nationwide. Daily-values data are uploaded from the local ADAPS daily-values data files to the WATSTORE daily-values file on the AMDAHL in this format.

32-bit microprocessor — A microprocessor that uses a word size of 32 bits.

aeromagnetic field — A representation of the earth's magnetic field as determined from measurements made from the air at some known distance from the earth's surface.

asynchronous — Data transmission in which each information character is individually synchronized, usually by the use of start and stop elements or bits.

band ratios — In remote sensing, the process of enhancing the spectral response of vegetation in an image. The process is as follows in terms of radiation: (infrared / red)

batch job — A program or a set of programs that is part of a sequential group or queue. Each member of the group is executed in turn as a job on the computer according to its position in the queue.

bathymetric data — Data describing the topology of a lake bottom with respect to the lake's water surface.

baud — A unit of signaling speed. The reciprocal of the duration, in seconds, of the shortest signaling element that a channel can accommodate. Commonly used units are bits per second.

bit — A unit of data that is indivisible. It is the choice between two possible states, usually designated one and zero.

byte — A sequence of adjacent bits operated on as a unit and usually shorter than a word.

central processing unit (CPU) — A CPU is made up of a processor unit that implements the operations in a computer and a control unit that supervises the sequence of micro-operations.

compiler — A program that translates high-level computer programming language (such as Fortran) into machine language.

coverage (GIS) — A GIS coverage is a set of information that digitally describes a geographic area using appropriate types of feature-class data.

digitizing — The process of converting data that is expressed visually in the form of maps, line charts, and so forth, into numeric form. The process can be manual or can be greatly automated by using an electronic digitizer.

disk storage — A storage medium available on most computers. The disks are magnetic and come with various storage capacities. Disks may be repositories for both data and computer programs.

double precision — A numeric representation may occupy twice the amount of space it normally would. For example, double precision might be specified for a numeric variable to adequately represent the precision required by a particular type of calculation.

ethernet — Facilitates communications between mini and mainframe computers, workstations, personal computers, and peripheral devices: Currently limited to 10 megabytes.

geographic information system (GIS) — Computer hardware and software system designed to collect, manage, analyze, and display spatially referenced data.

gravity field — A representation of the earth's magnetic field as determined from specific measurements made on the earth's surface.

hardware — Any physical equipment related to a computer including the computer itself.

image-processing — The process of interpreting, refining, and manipulating data collected by remote sensing or satellite imagery.

interactive — A mode of operation on computers in which the user is communicating directly with the computer through the operating system software or user software that has been invoked.

interface — A common boundary where independent systems meet and act on or communicate with each other.

limnology — The study of lakes.

local area network — A network of computer equipment that shares resources and is physically located at the same site.

mean slope curve — Method of determining slope of a surface on the basis of the relation between the width of the elevation contour interval and the corresponding changes in elevation.

megabyte — One million bytes (see byte).

menus — In computer terms, a menu is a list of available options that is displayed on the monitor screen. The user may select from the list and that selection determines the next course of action taken by the software that is currently invoked.

microcomputer — The term is general and refers to a small-size computer system with three basic units: central processing unit, memory, and an input-output interface.

modified contour length — A method of determining slope of a surface plane modified from traditional contour length method by subtracting a mean contour from the sum of contour lengths.

multitasking — Refers to a computer that can do multiple tasks concurrently.

multiwindowed — Refers to a computer that can display more than one interface on the monitor screen at the same time.

normalized difference — In remote sensing, the process of enhancing the spectral response of vegetation in an image. The process is as follows in terms of radiation:
$$(\text{infrared - red}) / (\text{infrared + red})$$

point-coverage file — A GIS coverage that has points defined by geographic location and associated attributes.

postscript — A page-description language used primarily for printing illustrations and including them in other documents.

random-access memory (RAM) — RAM is volatile, dynamic computer memory, sometimes referred to as 'main memory'.

raster data — Data representation using grid cells.

real variables — In computer programming, these are variables that are designated to represent real numbers.

relational data base — A data base that is made up of elements and files that are linked as a result of defined connections.

scanner — A device that can be used to interpret printed data and transpose that data into a digital form that can be used for further processing.

software — Software is computer programs.

termem program — A terminal emulation program currently in use on minicomputers in various Water Resources Division offices.

55

traditional contour length — The traditional method of determining slope of a surface plane based on summing lengths of contours, multiplying by contour interval, and dividing by area.

triangulated irregular network — A method of determining slope of a surface plane using a type of digital elevation model consisting of a network of irregular triangles created by interconnecting elevation points.

usage utility — A utility program provided with the PRIME minicomputers that allows the system administrator to evaluate system performance.

vector data — Data representation using line segments.

word — An ordered set of characters that is the normal unit in which information may be stored, transmitted, or operated on within a computer. Word sizes may vary from one type of computer to another.

workstation — A microcomputer that is connected through a local area network (LAN) to other, usually more powerful, microcomputers designated as servers and to other shared devices such as printers and plotters.

xoff/xon protocol — The means by which a computer or peripheral device is able to stop and start data transmissions in order to maintain the integrity of storage buffers.